place in the study of botany of this country can not be filled, for the conditions which made him have disappeared; but to many of us this loss will appear secondary, because we especially cherish the memory of the kind and helpful friend.

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On the archegonium and apical growth of the stem in Tsuga Canadensis and Pinus sylvestris.

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(WITH PLATE VIII.)

To determine the true relationship existing between the different groups of the plant kingdom is yet a problem of great interest to botanists. The genealogical tree is still largely hypothetical and must necessarily remain so for some time to come. Now and then modern research fills up a gap or throws some light on the true line of development.

The gymnosperms, holding as they do a position between the pteridophytes and angiosperms, are perhaps as interesting as perplexing. It is, however, chiefly in the study of the reproduction, the development of the embryo and the meristems of stem and root that we are to look for the true affinities of the neighboring groups.

Several representative types of the gymnosperms have been carefully studied by Hofmeister and, later, by Strasburger and others. Since more accurate methods have come into use some of the work done by these botanists has been repeated, especially in cases concerning which there was doubt or difference of opinion.

Having had material in abundance, I recently made a careful study of the development of the archegonium in Tsuga Canadensis and Pinus sylvestris and found that in a few details my results do not quite agree with the account of Strasburger.[1] This investigator states that he can not affirm Hofmeister's statement that the neck of the archegonium of Tsuga Canadensis consists of two cells, one lying above the other, but that it remains one-celled, and only in rare cases did he find two. In a large number of specimens examined I found

[1] Die Befruchtung bei den Coniferen, p. 6. Jena, 1869.

the neck to be frequently of two cells (figs. 1 and 2). In one instance I found the lower cell divided by a cross wall, thus making three cells in all (fig. 3). This, however, is exceedingly rare for it was the only case observed out of the large number of ovules sectioned. In Pinus sylvestris the cells of the neck formed two layers instead of one (fig. 4) as stated by Strasburger.[1] Four cells lie in one plane (fig. 4a), making eight cells in the entire neck. At the stage of development represented in fig. 4 the ventral canal cell had not yet been cut off. A very large nucleus lay just beneath the neck while the remainder of the cavity of the archegonium was filled with granular protoplasm staining deeply with alum cochineal and containing many large vacuoles. In figs. 1 and 2 (Tsuga) the archegonium is mature, the ventral canal cell consisting almost entirely of a very large nucleus. The nucleus of the egg-cell occupied a central position. As regards other details in the development of the archegonium, I find them to agree with the account of Strasburger.

Apical growth of the stem.

In the BOTANICAL GAZETTE for January, 1892, Conway MacMillan, in a review of the work of Duliot on apical areas in seed plants, reports that author as concluding that in the gymnosperms the apical growth in the stem proceeds from a single apical cell. Unfortunately I have not had access to Duliot's paper, and do not know what species were studied; but from my investigation upon the stem of Pinus sylvestris the conclusion of Duliot seems to be very hasty at least. The growth in Pinus sylvestris corresponds very nearly with Strasburger's account for *Pinus Pumilio.*[2] A pretty well defined dermatogen layer passes over the entire apex which is relatively very large and cone-shaped at the period of active growth. The dermatogen is sharply defined from the periblem (fig. 5, *pb.*); so also the definition between periblem and plerome is very distinct (fig 5, *pl.*). At the extreme apex, however, the dermatogen cells are very much larger than the others, with very large nuclei. These (*x*, *x'*) I take to be the initial cells. In this specific instance the dermatogen, periblem and plerome can all be traced to one or two large cells at the apex. This condition of things appears in three or four consecutive sections, though with not such great regu-

[1] l. c., p. 13.
[2] Die Coniferen und die Gnetaceen, pp. 327, 328. (1872.)

larity, showing that the apex is relatively broad. Transverse sections taken from the extreme tip show that it terminates in two or three large cells (figs. 6, 7), and it seems to me that we can not say with certainty that there is only one initial cell. Figs. 6 and 7 are consecutive transverse sections taken from the apex. In fig. 7 we have a near approach to what would lead one to regard the large cell, *x*, which has apparently just cut off a segment, *x''*, as the initial cell, both from its size and regularity in the arrangement of the cells about it. Yet this does not seem sufficient proof to warrant the conclusion. Fig. 5 is the only instance in which I found such great regularity; in all others the apex terminated in two or three large cells, which may be regarded as initial cells, but all approached nearly that shown in fig. 3.

In the apex of the stem of the embryo taken from the seed of Pinus sylvestris and Tsuga Canadensis, we find the nearest approach to a single apical cell (figs. 8, 9 and 10). It is quite probable that in the young state growth takes place from a single apical cell. In instances like that of fig. 8 this seems quite certain. In the embryo of Tsuga (fig. 10) this also seems to be the case, but in fig. 9 we can not be so positive as to the initial cell. A transverse section from the tip of the stem in a similar embryo shows two or three cells of uniform size (fig. 11).

In view of these facts it seems to me that we can not say that there is a single cell at the apex of the stem of the species under consideration, unless it be in the stem of the young plant, and even then not with absolute certainty.

All material used in this study was hardened in chromic acid (1 per cent.), thoroughly washed, stained *in toto* with alum cochineal or alum carmine, washed and dehydrated; then brought gradually into a saturated solution of xylol and paraffine, then into melted paraffine, imbedded and sectioned with a Minot microtome. The sections were counter-stained on the slide with Bismarck brown.

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EXPLANATION OF PLATE VIII.— Figs. 1, 2 and 3, longitudinal sections showing neck of archegonium of *Tsuga Canadensis; vc*, ventral canal cell. Fig. 4, same of *Pinus sylvestris;* 4 *a*, transverse section through the neck of archegonium of P. sylvestris. Fig. 5, longitudinal section through the apex of the stem of P. sylvestris; *pb*, periblem; *pl*, plerome. Figs. 6 and 7, consecutive transverse sections of the apex of the stem of P. sylvestris. Figs. 8 and 9, longitudinal sections of the apex of the embryo stem taken from the seed of P. sylvestris. Fig. 10, same of Tsuga Canadensis. Fig. 11, transverse section of the extreme apex of the stem of the embryo of P. sylvestris.

All magnified 175 diameters, except fig. 8, 150 diameters.